



PCT/GB03/000868
INVESTOR IN PEOPLE #2

PRIORITY DOCUMENT
SUBMITTED OR TRANSMITTED IN
COMPLIANCE WITH
RULE 17.1(a) OR (b)

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ
REC'D 06 MAY 2003
WIPO PCT

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

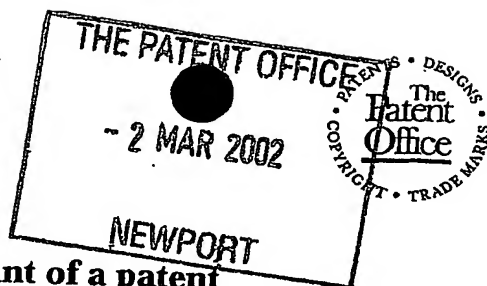
Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed

Dated 7 April 2003

An Executive Agency of the Department of Trade and Industry

BEST AVAILABLE COPY



04MAR02 E700366-3 002884
P01/7700-0:00-0204932.8

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
South Wales
NP10 8QQ

1. Your reference

P31011/AHO/PPP

2. Patent application number

(The Patent Office will fill in this part)

0204932.8

- 2 MAR 2002

3. Full name, address and postcode of the or of each applicant (underline all surnames)

Robert CAMPBELL
51 Netherpark Avenue
Netherlee
GLASGOW G51 1HD

Patents ADP number (if you know it)

732048403

If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention.

"Analysis System for Plant Real-Time Integrity Assessment"

5. Name of your agent (if you have one)

Murgitroyd & Company

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

Scotland House
165-169 Scotland Street
Glasgow
G5 8PL

Patents ADP number (if you know it)

~~4198043~~

8330578002

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

Priority application number
(if you know it)

Date of filing
(day / month / year)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing
(day / month / year)

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:

No

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or

c) any named applicant is a corporate body.
See note (d))

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form

Description

13

Claim(s)

Abstract

Drawing(s)

7 4 7

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for preliminary examination and search (Patents Form 9/77)

Request for substantive examination (Patents Form 10/77)

Any other documents (please specify)

11. I/We request the grant of a patent on the basis of this application.

Signature

Murgitroyd & Company

Date

1/3/02

12. Name and daytime telephone number of person to contact in the United Kingdom

Paolo Pacitti

0141 307 8400

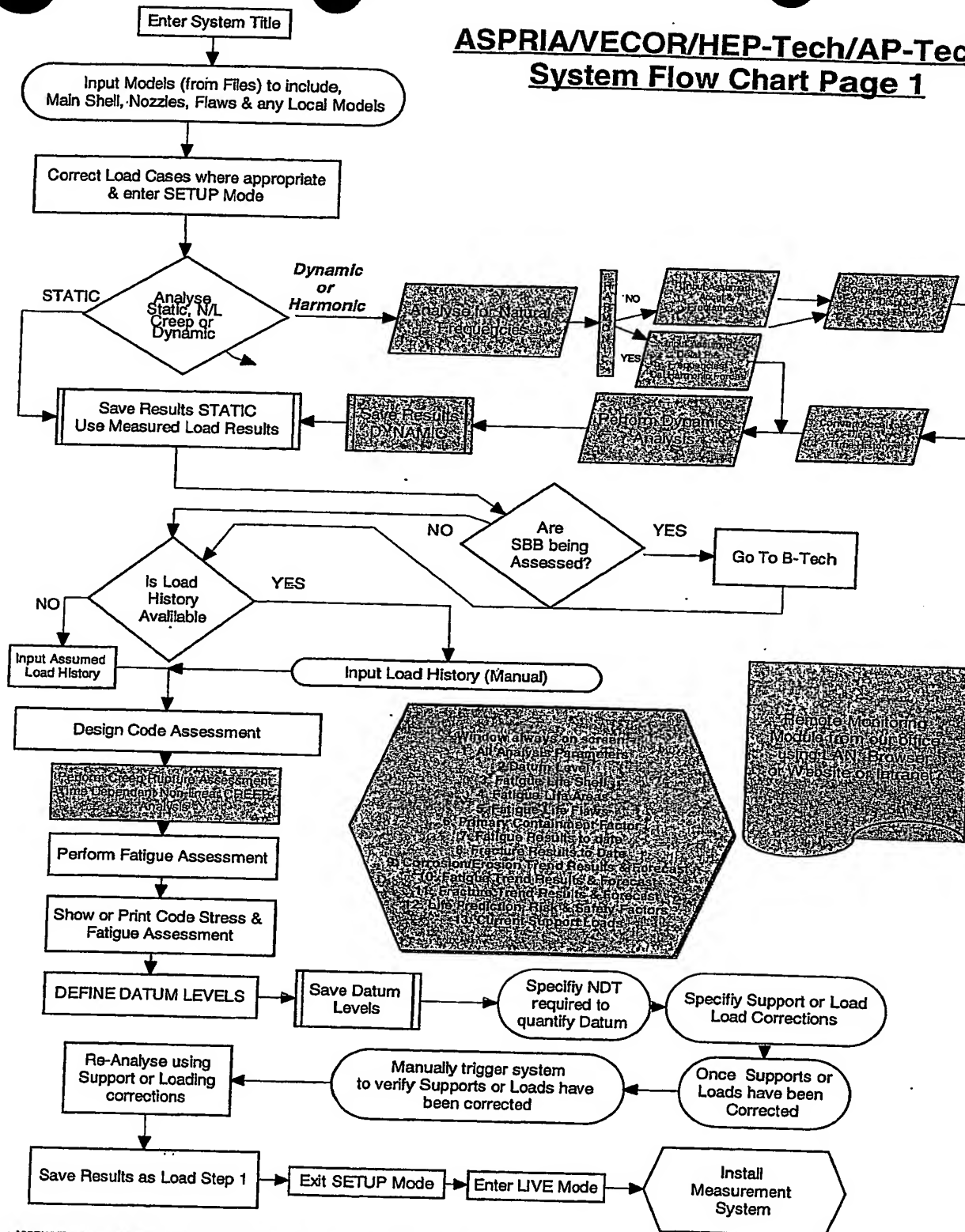
Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

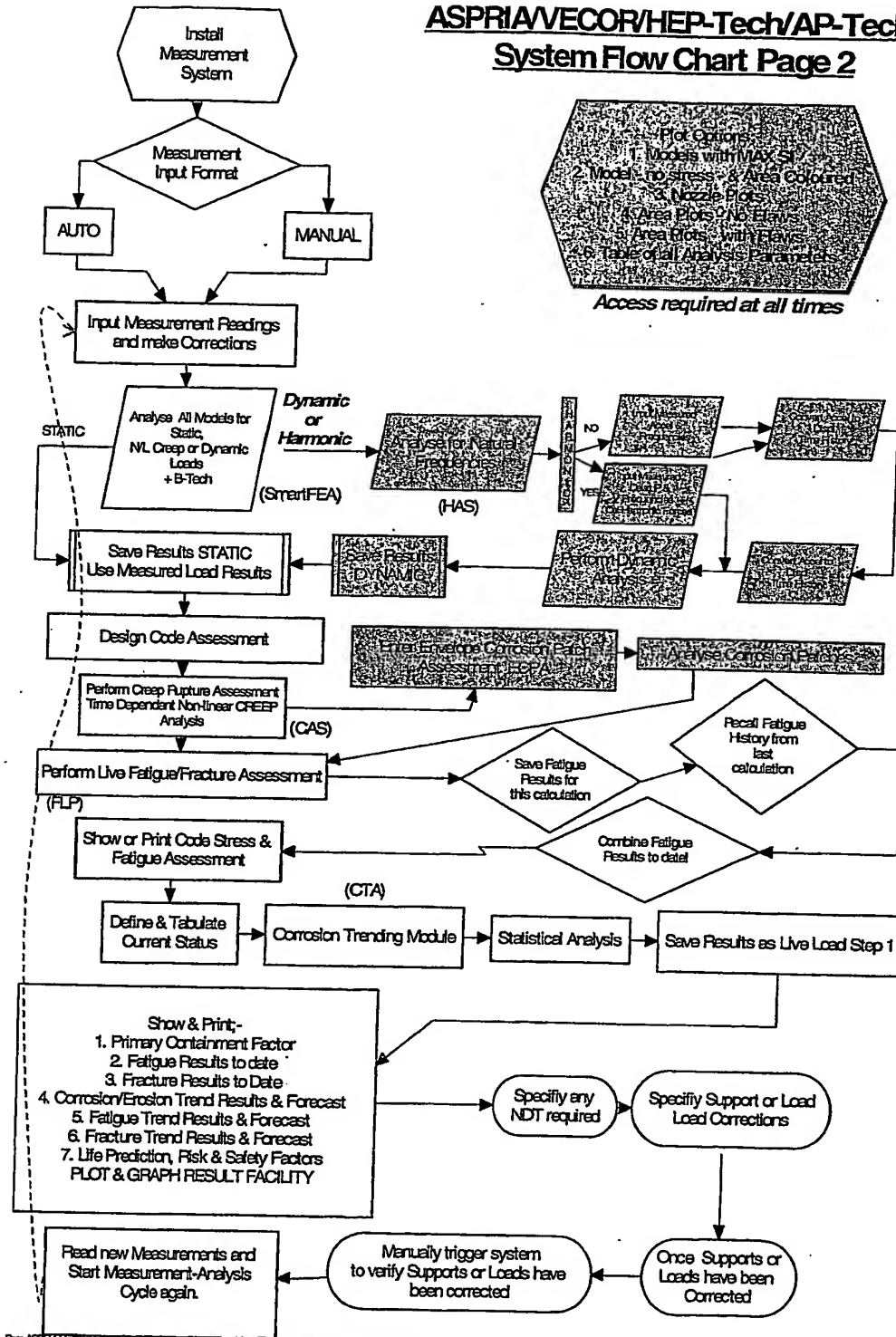
- If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.
- Write your answers in capital letters using black ink or you may type them.
- If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.
- If you have answered 'Yes' Patents Form 7/77 will need to be filed.
- Once you have filled in the form you must remember to sign and date it.
- For details of the fee and ways to pay please contact the Patent Office.

ASPRIA/VECOR/HEP-Tech/AP-Tech System Flow Chart Page 1



Doc: ASPRIA/VECOR/HEP-Tech/AP-Tech-20/10/2001-RC Originator: Robert Campbell on 20th October 2001

ASPRI/VECOR/HEP-Tech/AP-Tech System Flow Chart Page 2

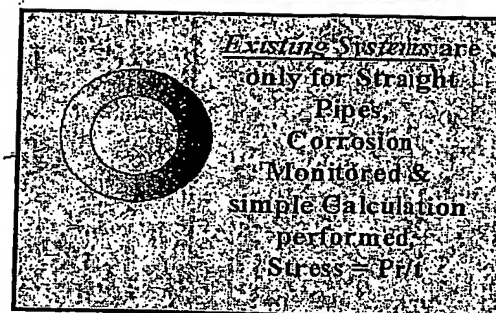
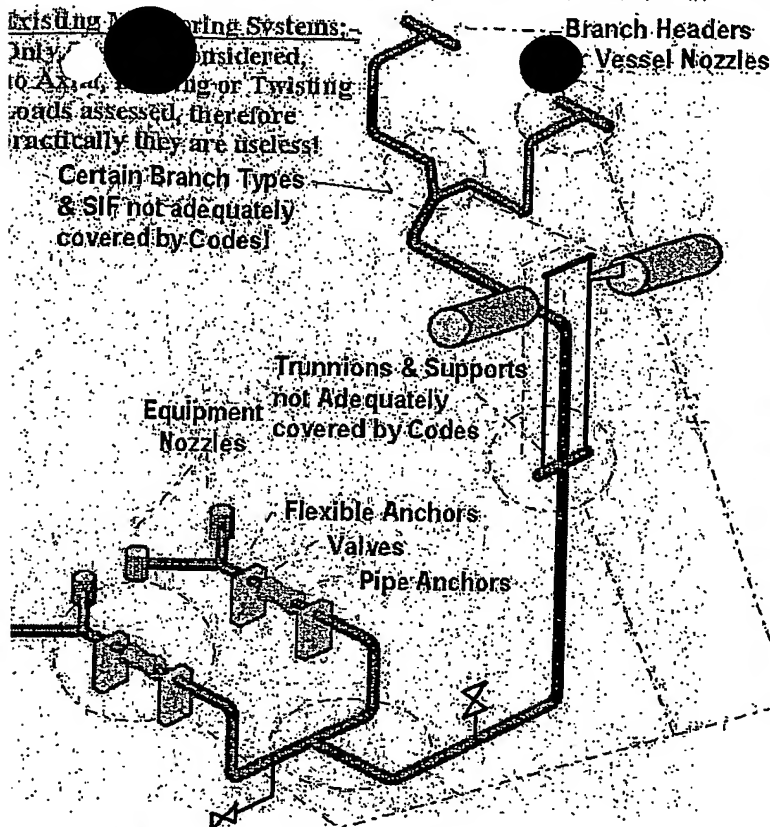


Doc: ASPRI/VECOR/HEP-Tech/AP-Tech/2010/2001/PCD Orig: Robert Campbell on 20th October 2001

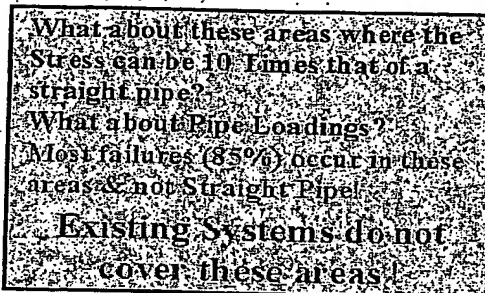
EXAMPLE OF THE CAPABILITIES OF EXISTING SYSTEMS;-

Existing Engineering Systems:-
Only Vessel Nozzles considered,
to Assess Bending or Twisting
loads assessed, therefore
practically they are useless!

Certain Branch Types
& SIF not adequately
covered by Codes!

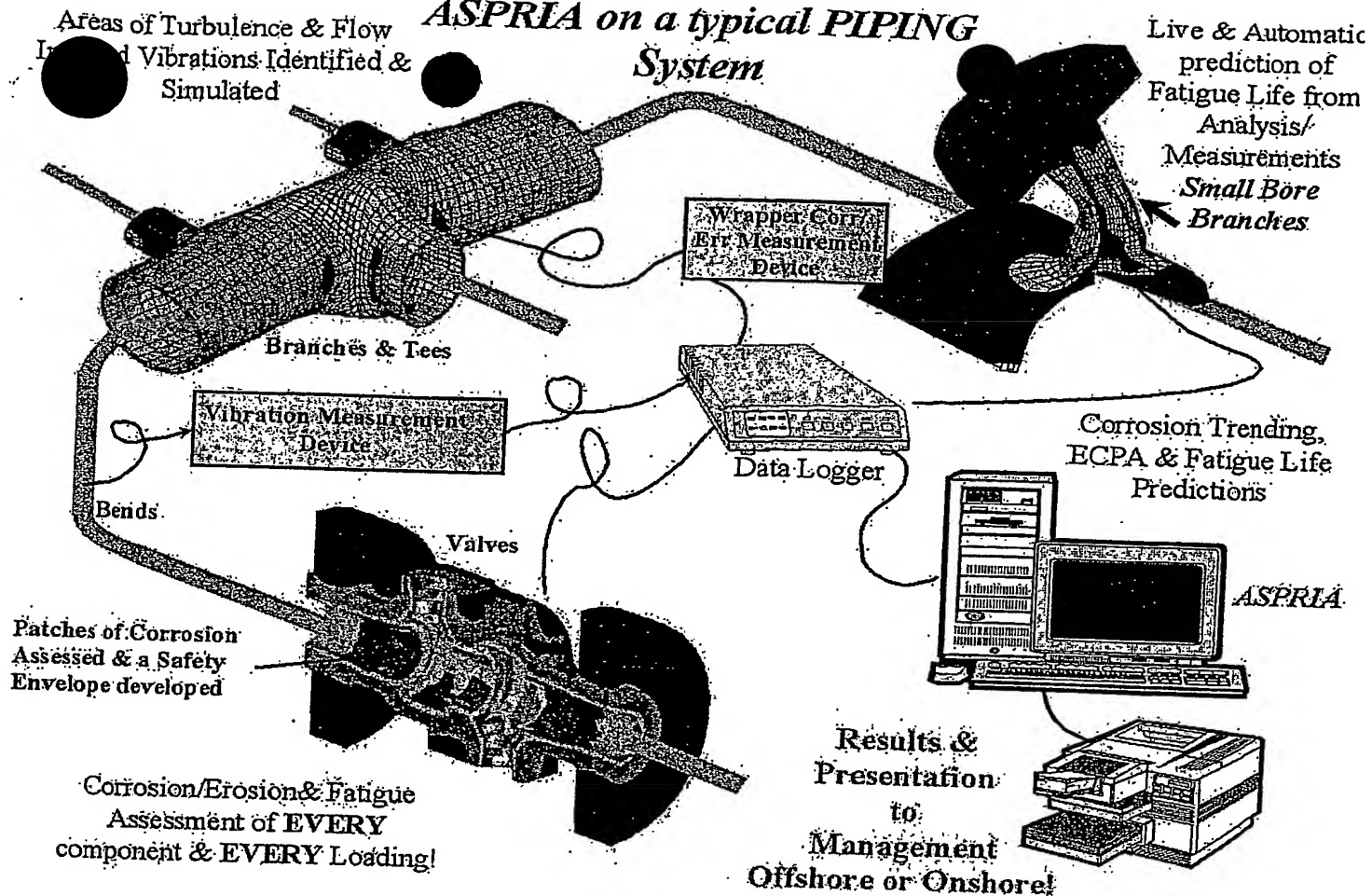


Nothing useful is found relating to
Plant Life.



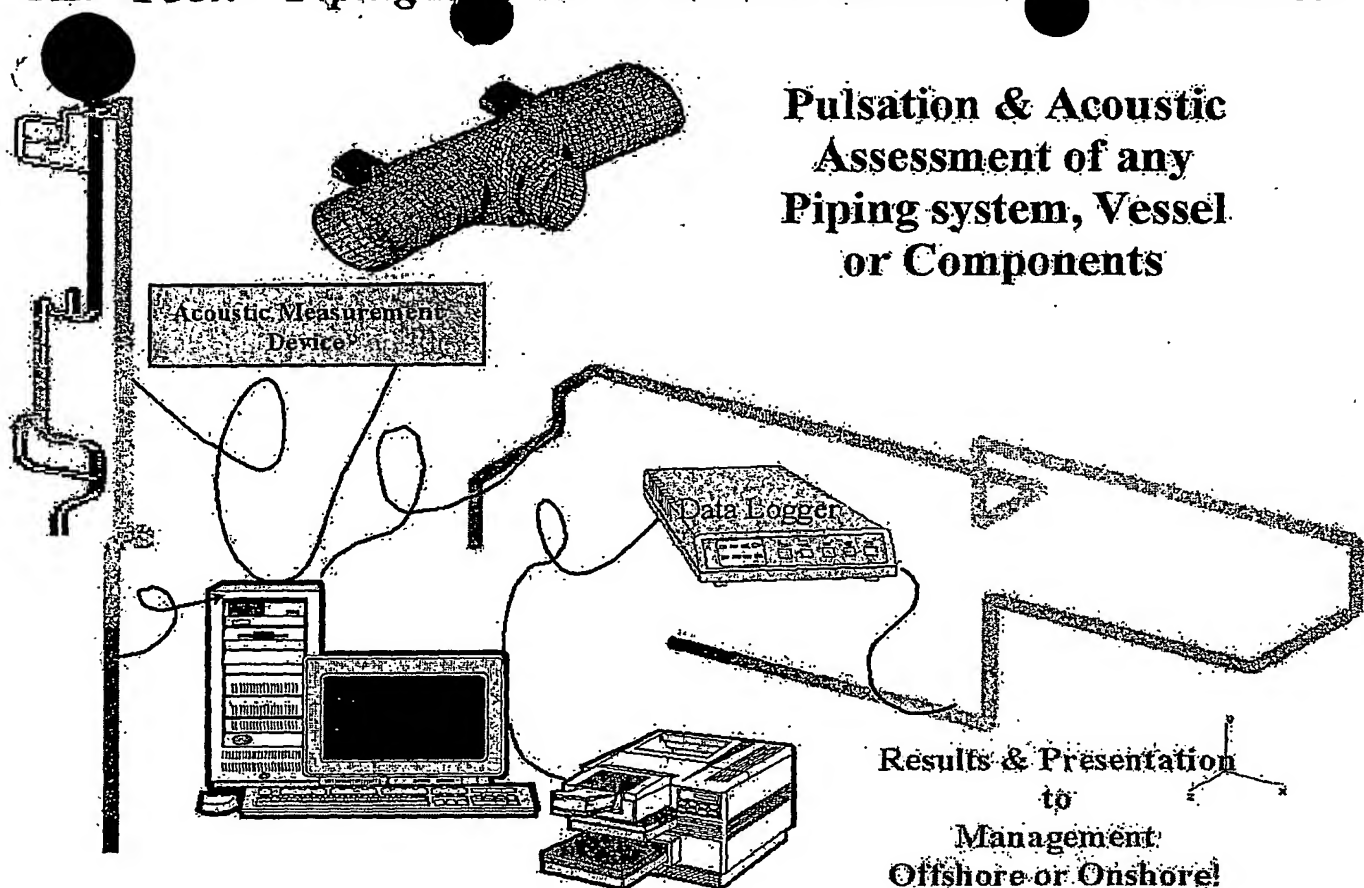
- * Small Bore Branches Ignored!
- * Vibration ignored or undertaken by on a project basis, not on-line & live!
- * Fluid Transients ignored undertaken by on a project basis, not on-line & live!
- * Acoustic Pulsations Ignored!
- * Corrosion/Erosion ignored at highly stressed areas which determine Plant Life!

ASPRIA on a typical PIPING System



AP-Tech - Piping Acoustic Pulsation Monitoring & Simulation

**Pulsation & Acoustic
Assessment of any
Piping system, Vessel
or Components**



BEST AVAILABLE COPY

VECOR on a typical PRESSURE VESSEL

Every Welded Area Simulated.

Live & Automatic prediction of Fatigue Life from Analysis/Measurements

Wrapper Corr./Eros. Measurement Device.

Vibration or Acceleration/Frequency Measurement Device.

Data Logger

Corrosion Trending, ECPA & Fatigue Life Predictions

Patches of Corrosion Assessed & a Safety Envelope developed

Corrosion/Erosion & Fatigue Assessment of EVERY component & EVERY Loading!

VECOR

Results & Presentation to Management Offshore or Onshore!

Live & Automatic
prediction of
Life from
Analysis/
Measurements.

HEP-Tech on a typical High Energy PIPING System

Corrosion/Erosion & Vibration
Measurement
Devices

Support/
Load Measurement
Device

Data Logger

Load & Corrosion
Trending, ECPA &
Fatigue Life Predictions.

HEP-Tech

Results &
Presentation
to
Management

Offshore or Onshore!

Support Load, Creep, Corrosion/Erosion
& Fatigue/Fracture Assessment of **EVERY**
component & **EVERY** Loading!

1 "Analysis System for Plant Real-Time Integrity
2 Assessment"

3
4 This invention relates to the assessment of the
5 integrity of plant such as petrochemical process
6 plant.

7
8 As is discussed in more detail in the Annex hereto,
9 existing systems for monitoring or assessing the
10 integrity of plant suffer from significant
11 inaccuracies, and do not operate in real time. The
12 present invention seeks to overcome or mitigate
13 these problems.

14
15 Accordingly, the present invention provides a method
16 of continuously assessing the integrity of a given
17 plant in real time, the method comprising
18 continuously acquiring data related to plant
19 parameters, analysing the data in accordance with
20 predetermined criteria to give an assessment of
21 integrity, transferring said data to a computer
22 model, and re-analysing the data taking account of

1 measurements related to the history of the plant to
2 generate predictions as to future integrity.

3

4 Said data may comprise measurements of parameters
5 such as pressure, temperature and stress at multiple
6 locations in the plant. The measurements related to
7 the history of the plant may include plant physical
8 changes such as geometry changes, corrosion, fatigue
9 and fracture, and cumulative operating conditions
10 such as vibration and acoustic pulsations.

11

12 The generated predictions may include estimated time
13 to failure, predicted life of plant, and maintenance
14 shutdown required.

15

16 Further details of the invention are given in the
17 Annex, together with specific embodiments by way of
18 example.

ANNEX

CONTENTS

1. The Products
2. Technical Description
3. Level of Innovation

Annex 1. - Drawings and Sketches of *ASPRIA, VECOR, HEP-Tech & AP-Tech*
Components

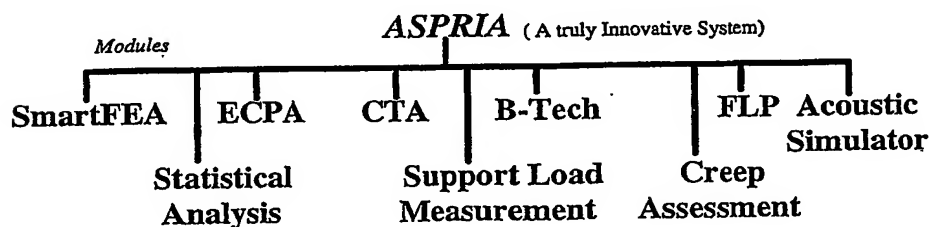
1. The Products

The greatest source of failures and shutdowns in Process Plant are in Piping systems and there is no system in the world that monitors and assesses these systems adequately at present. All existing systems, simply monitor the wall thickness of straight pipe, perform a simple calculation and predict a trend. Alternatively, Machinery based Corrosion and Vibration Monitoring systems are used. These are all grossly inaccurate as over 85% of failures (from Hydrocarbon magazine) occur at non-straight pipe areas, due to Structural loadings, Corrosion/Erosion, Fatigue or Pulsation or Vibration. No system in the world covers these areas or load-changing mechanisms live as they occur. **ASPRIA** & its sister products, **VECOR**, **HEP-Tech** & **AP-Tech** do exactly that. Also, no existing system monitors 'live', the deterioration of Supporting systems such as Pipe Supports and assesses these effects on the piping or Vessel system to determine the true effect on Structural Integrity

Additionally, many people carry out Acoustic Pulsation, Vibration and Condition Monitoring but these are specialist tasks and because they are extremely expensive, they are only undertaken (other than for Rotating Equipment) if failure is suspected or has occurred. There are plenty of Plant Maintenance Programmes available but these are extremely limited, consisting mainly of a Database and statistical trending, and none of these address the more important aspects of **Reducing Structural Integrity** due to in service pulsations, Vibration, Fatigue or Corrosion/Erosion, that require complex Stress Analysis. This is because none of the authors of these systems have the knowledge or understanding of the influence of Stresses, Fluid Transients, Acoustic Pulsations, Vibration and Fatigue in any System of Plant or Structure. This is a specialist function, therefore Prior Art is very limited technically.

IDEAS Ltd have developed a system with a range of key aspects of 'core' technology for a Structural Integrity Management & Monitoring system, which would cover these specialist areas. This system was labelled **ASPRIA**.

Analysis System for Plant Real-time Integrity Assessment – ASPRIA



ASPRIA is revolutionary compared to Prior Art in that it addresses that level of technology which is unique and desirable in today's market, ie;- a system that will carry out the work of a Specialist by Automatically assessing and analysing the status of any system to assess the effects of Corrosion, Erosion, Branch Vibration, Acoustic Pulsation, Fatigue, Fracture, etc. and constantly monitor and predict the Plant/Structure Integrity and Safety which can be more accurately controlled at a fraction of the current costs and the 'risks' in Risk Assessments can be minimised, i.e. the most desirable and innovative concept in Preventative Maintenance.

By combining Stress Analysis and Statistical Analysis with continuous in-situ 'live' measurement, for a first time, a quantifiable safety statement will be available to the client &

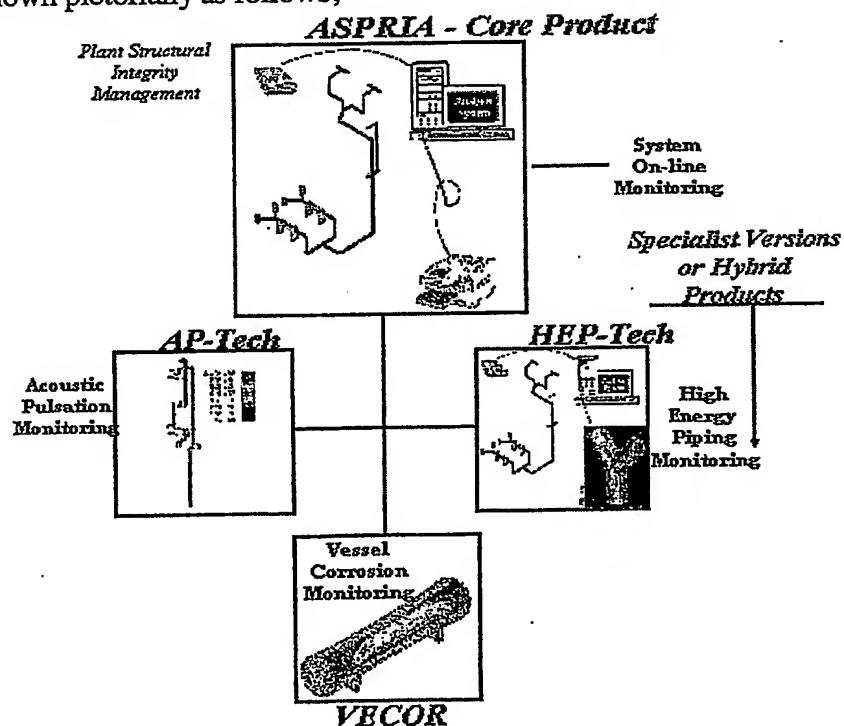
Health & Safety Executive.

The client is given a simple printout, whenever desired, of the System Status, Plant Integrity and therefore Plant/Structural Safety, plus any essential or significant maintenance or shutdown date. The complete **innovative process** would be automatic, revolutionary and the client would know the realistic situation without the need to call in experts or ignore it. **ASPRIA** will minimise the Risk from potential Catastrophic failures. A Diagram & Flow Chart of **ASPRIA** is shown in Annex 1.

ASPRIA can be used in many Markets. It is essential that **ASPRIA** is packaged in such a way as to be appealing not only to a wide range of markets but to a range of areas within a range of markets. For this reason, 'Specialist Versions or Hybrids' of **ASPRIA** (using the same technology) have been created for marketing purposes as follows:-

Product	Function	Market
ASPRIA	Corrosion/Erosion Monitoring	ALL but primarily, Oil & Gas, Petrochemical & Water
Hep-Tech	High Energy Piping Monitoring	Power Plant with High Energy Piping
AP-Tech	Acoustic Pulsation Monitoring	Gas Compressions, LPG systems, FPSO's & Ships
VECOR	Pressure Vessel, Exchanger, & Tank Monitoring	ALL Markets

These can be shown pictorially as follows:-



It is however very important to appreciate that this is not four products but one, parcelled into

four bundles to suit marketing strategies. Each 'Specialist Version or Hybrid' of ASPRIA can be described as follows:-

- '**ASPRIA**' - Analysis System for Plant Real-time Integrity Assessment
- '**VECOR**' - Pressure Vessel, Heat Exchanger & Storage Tank – Corrosion/Erosion Structural Integrity Analysis & Management System
- '**HEP-Tech**' - High Energy Piping Structural Integrity Analysis & Management Technology System
- '**AP-Tech**' - Acoustic Pulsation Structural Integrity Analysis & Management Technology System

Each 'product' will use the same core technology, but will utilise its own measurement techniques and its own post processing and reporting system.

The **ASPRIA** system would constantly measure geometric thickness values in Piping Systems affected by Corrosion/Erosion/Vibration, etc. A detailed geometric update will then be performed and the unit, whether a piece of plant such as pipework, a structure, or fabrication, will undergo an **Automatic and Complete** Finite Element Stress Analysis using '**SmartFEA**' and advanced Error estimation techniques to determine the degree of accuracy.

The **HEP-Tech** system would constantly measure Support Load values affected by deterioration and high temperature Creep. A detailed Load update will then be performed and the pipework will undergo an **Automatic and Complete** Finite Element Stress Analysis using '**SmartFEA**' and advanced Error estimation techniques to determine the degree of accuracy. The system will be assessed and the load corrections required highlighted for adjustments which should be made to ensure Structural Integrity.

The **AP-Tech** system would constantly measure Acoustic Pulsation Pressure Waves and Frequencies values affected by Acoustic Pulsation & Vibration, etc. A detailed Load update will then be performed and the pipework will undergo an **Automatic and Complete** Dynamic Finite Element Stress Analysis using '**SmartFEA**' and advanced Error estimation techniques to determine the degree of accuracy. **AP-Tech** will use a unique non-intrusive method to measure Acoustic Pulsations using a technique of Impedance Cables of PDF Measurement Cabling.

The **VECOR** system would constantly measure geometric thickness values in Pressure Vessels, Exchangers & Tanks affected by Corrosion/Erosion/Vibration, etc. A detailed geometric update will then be performed and the unit will undergo an **Automatic and Complete** Finite Element Stress Analysis using '**SmartFEA**' and advanced Error estimation techniques to determine the degree of accuracy.

All four systems have the option of utilising Accelerometers to include the effects of system Vibration.

These, unlike any systems on the market, will include non-corrosion effects such as Structural Loadings, Temperature, Creep behaviour, Acoustic Pulsations, Fluid Transients, Vibration and Support Load Variation.

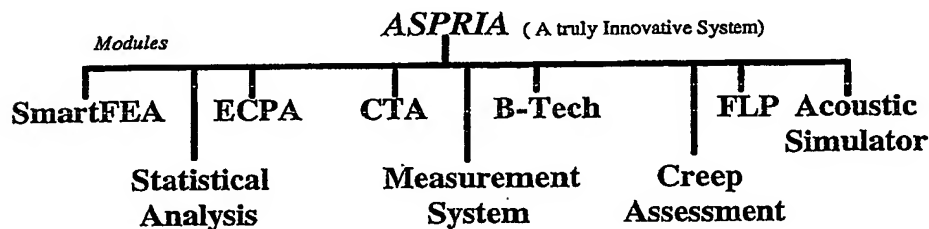
The systems can be set up for Pipework or any piece of Plant, Pressure Vessels, Equipment,

Civil Buildings, Structures, Ships and Buried Pipe.

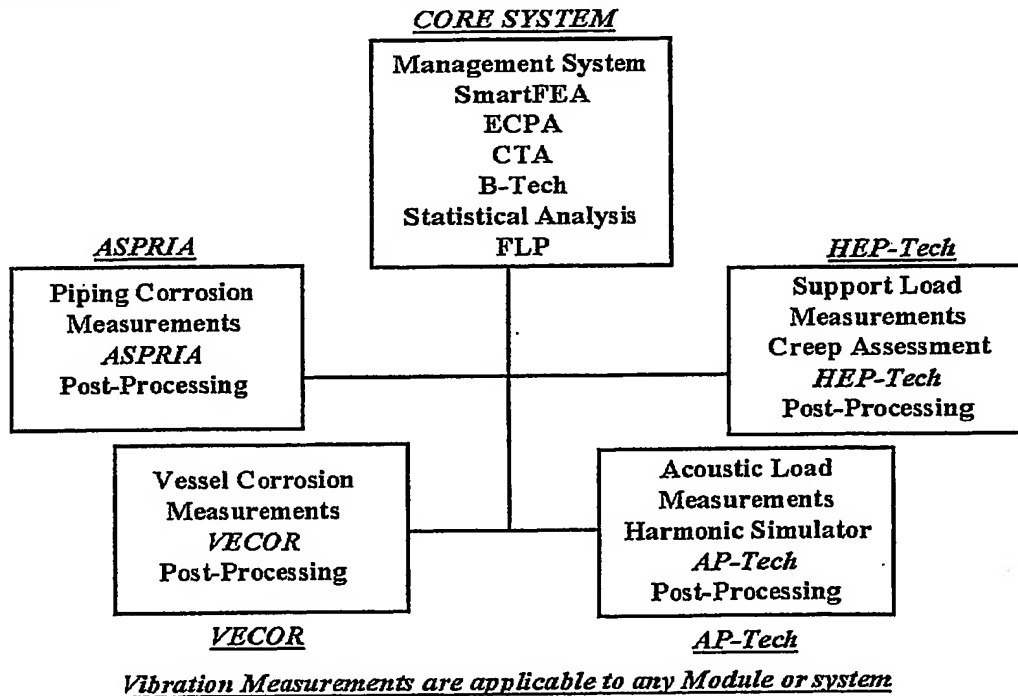
It is believed that these concepts are unique. There are companies who do analysis as consultants but this is always after a failure or if danger is suspected. The work requires experienced consultants and is therefore expensive and unappealing to clients until they have no alternative. As a consequence, very often they ignore the situation and as a result, Lives, Plant and the Environment not to mention their Finances, are in great danger.

2. Technical Description

The system consists of Software & Hardware. A graphical representation of the system is shown in Annex 1 and a summary description is as follows;-



These modules would be combined to make the four systems as follows;-



There is an overall Management System for *ASPRIA/HEP-Tech/AP-Tech/VECOR*. This System manages and controls the *ASPRIA/HEP-Tech/AP-Tech/VECOR* components and will produce the Clients Management Reports.

Management System

This is a Management Software system to manage the *ASPRIA/HEP-Tech/AP-Tech/VECOR* components, *Measurement Systems, SmartFEA, ECPA, CTA, B-TECH, Statistical Analysis, FLP, Acoustic Harmonic Simulator and Creep Assessment*.

The *ASPRIA/HEP-Tech/AP-Tech/VECOR* master system would consist of a series of modules called *Measurement Systems, SmartFEA, ECPA, CTA, B-Tech, Statistical Analysis, FLP, Acoustic Harmonic Simulator and Creep Assessment*, as follows:-

1. *SmartFEA* is the main analysis tool. Extremely powerful, it is based on Finite Element Analysis technology, a 3D FEA system. This includes advanced error estimation techniques. This system, or '*SmartFEA*', is a black box routine for the end user. The system contains the 'as-built' model of the Piping system plus components and receives the regular measurement data; then updates the Finite Element Model, performs the advanced FEA and passes the Results to the Envelope Corrosion Patch Assessment (ECPA) system.

2. *ECPA* , the **Envelope Corrosion Patch Assessment** module is an innovative method that has been derived to assess the effects of 'Patches of Corrosion' in various regions of each component to generate an envelope of possible conditions that will allow *ASPRIA* to predict the earliest possible danger signs for each component or system. The results from the analysis system *SmartFEA*, are revised to account for random Corrosion patches which are monitored at the key areas for each component. The results of the analysis is modified to account for the most likely emerging patch shape and where the results are becoming nearer the limiting values, then recommendations are passed back through system, so *SmartFEA* can modify the Finite Element Mesh (Mathematical Model) and re-analyse to include the Corrosion Patch.

3. *Corrosion Trending Analysis (CTA)*. This module Analyses the history and Trends the future effects of Corrosion and Erosion in the system and builds up a history of the effects and derives continually updating correlation's to predict Corrosion Rates, Patterns, etc. for the **Statistical Analysis module**.

4. *Creep Assessment Systems (CAS)*. Where there is High Temperature, as in High Energy Piping Systems, this module will Analyse the Temperature and Time history and a Creep Analysis of the System will be carried out to simulate the Stress changes due to Time dependant Temperature effects in the Piping system and will build up a history of the effects and derive continually updating correlation's to predict Creep Rates, Patterns, etc. for the **Statistical Analysis module**.

5. *Harmonic – Acoustic Simulator (HIS)*. Where there is Acoustic Pulsations, as in Gas Compression Systems, This module Analyses the Acoustic Pulsations in the system by Harmonic Analysis to simulate the Stress changes due to Acoustic Pulsations in the Piping system. The history is then stored and trends predicted for the future effects of Acoustic Pulsations in the system and the system builds up a history of the effects and derives continually

updating correlation's to predict Cyclic Stress Patterns, etc. for the **Statistical Analysis module**.

6. **Statistical Analysis.** This module takes all of the Piping systems Loading history, Cyclic patterns, Operational Data, Corrosion & Erosion & B-Tech Vibration data and Trends. This is then Statistically Analysed to provide realistic and meaningful Loading versus Time History Data for the **FLP** Module to predict the Life left in the system before Shutdown or Failure. Standard Statistical Analysis is then employed in the system.

7. **B-Tech.** This module receives 'Live Measurements' that are taken as described above, including some key Frequency data, measured live by accelerometers, **at the small bore Branch connections (SBB's)**. The '**B-TECH**' part of **ASPRIA**, then performs extensive mathematical correlation's, unique IDEAS LTD. algorithms and innovative techniques to predict the effects of the Vibration *live* and more importantly predict the Fatigue Life *live* for that part of the system automatically from the measured data, so as to alert the user and avoid failure. Another innovative part of this module is that it does not only predict the Fatigue Life from the Vibration, but will predict which Vibration Excitation will cause problems for each particular arrangement and flag this up if that level of Vibration is detected. The results will then be passed to the **FLP** Module.

8. **Fatigue Life Predictions (FLP)** This module performs the **Fatigue Life Predictions** and **Fracture Mechanics Assessments** that are basically the advanced **Life Forecasting system** that incorporates the latest advances in Fatigue & Fracture Technology but also includes our innovative concepts of **Fatigue & Fracture Life Correlation's** automatically from **Real Life Vibration & other Loadings.**

This will be the last module and will present the client with a simple statement of Structural Integrity for the system and show the Life expectancy and shutdown requirements to maintain a safe plant.

These Modules are the key elements of the Software and are linked via the Hardware Systems to form the full **ASPRIA/HEP-Tech/AP- Tech/VECOR** systems.

9. **Hardware** The Hardware aspects of the system will include,

- **Ultrasonic Blanket Thickness Measuring Devices**
- **Accelerometers**
- **Data Transmittal Devices to the system**
- **Data Interface Devices to the system**
- **Robust device for housing the Measuring devices and Accelerometers so as to avoid movement and damage from Thermal Expansion, Vibration and Physical Damage.**
- **Acoustic Measurement system based on Non-Intrusive PDF system**
- **Pipe Support Load Measurement Cells**
- **Strain Gauges**
- **Acoustic Emission System**
- **Patch Corrosion Measurement Devices**
- **Radiography Interface**
- **MAP Scan Interface**

10. **Prototype Testing and Verification** An Initial Test Rig is being built to run Benchmark

Tests to verify the system. Subsequent to this, a Prototype system will be created and installed on a clients site to enable further tests and obtain a client reference point.

The Technical Approach will be to select and customise a suitable range of available Measurement Devices to suit the range of applications. The Acoustic Pulsation measurement system will be developed on an Impedance Cabling Technique being developed by ourselves.

A Test Rig is being designed to verify the interaction of the Measuring Device results and the Analytical procedures under various conditions. This series of tests will be carried out prior to using the system on a clients site.

An Recording/Analysis system would link to the Measuring Device and immediately record the measuring results. We have developed a unique system to manage, Control and Record the Data at prescribed intervals and gather the necessary data for analysis. Also developed is the innovative and unique System and its Modules to allow automatic model modification, analysis and post-processing of results, through to Results Presentation to the Clients.

Due to this innovative Technology, the clients would have, for the first time ever, a system that is truly unique to their Plant systems. This leaves Prior Art in the dark ages.

The above will constitute systems that will do the work of Specialists and will Automatically monitor the status of any system or Plant item, e.g. Piping, Structures and Vessel/Tanks.

It has been very complicated to develop such specialist systems, advanced algorithms and correlation's for *SmartFEA*, *ECPA*, Corrosion and 'Patch' trending, and Statistical Life prediction, including Life Predictions *live* from Real Life Loadings including Vibration.

The main Technical aspects overcome in the development of the system can be described as follows:-

- a) Development of a system that combines Piping, Beam, Spring, Shell & Solid Finite Elements and large detailed Solid Models for each component in the piping system. This has been done on a large scale.
- b) Development of a Software System to accurately predict the effects of actual Site Vibration of Piping Branch connections Stress Intensification Factors for each of the configurations for a random range of Piping Component shapes, directly from the measured Acceleration data.
- c) Development of a Software System to accurately predict the effects of actual Vessel & Piping systems combined with the local effects of Corrosion/Erosion and also the random Patch assessment of localise Corrosion Flaws.
- d) Development of System to accurately measure by un-intrusive techniques and monitor the Acoustic Pulsations and the Dynamic solver to transfer this data to predict the effects of actual Site Pulsation & Vibration of systems
- e) Development of a fast, but accurate Analysis Software System to accurately predict the Fatigue & Fracture Life remaining for each of the configurations for a random range of Piping, Vessel & Structural Component shapes subject to various types of loadings including Vibration.
- f) Development of an accurate Analysis Software System to accurately predict the Risk and Safety Factors for each component and the system when subjected to Vibration

- g) Development of the Algorithms and a Database of the potential Corrosion trends and Patch shapes, depth variation patterns that will occur.
- h) Development of a fast, but accurate Software System to collect the measured data and the Algorithms to predict and define the emerging Patch Shape that is most realistic and appropriate.
- i) Development of a fast, but accurate Corrosion/Erosion Trending Software System to receive the SmartFEA data and predict the Trending effects of both Random Corrosion and Corrosion Patches for a random range of Piping Component shapes and not just Straight Pipes or Pipelines. Develop a range of Algorithms that will cater for such a range of complex shapes.
- j) Development of a Time Dependant Non-linear solver for the Creep Analysis was difficult to create and verify.
- k) Development of a Harmonic solver for the Pressure Pulsation Analysis was difficult to create and verify.
- l) Development of a ECPA System
- m) Development of a Pipe Support Load Measurement System.

3. Level of Innovation

Any systems or concepts that exist which constitute Prior Art, fail to solve the problem of deterioration in Structural Integrity. They only deal with simple straight pipes and perform a very basic Hoop Stress calculation which is, $\text{Stress} = \text{Pressure} \times \text{Radius} / \text{wall thickness}$, and that is the Structural Integrity Limit of the Prior Art. Over 90% of Piping systems have components other than straight pipes. It is these other components which are the major source of Plant Failures (85% according to the Hydrocarbon Magazine), therefore the Prior Art is almost irrelevant in real terms. Also, existing systems only look at 'Pressure Loading', when the vast majority of failures occur due to other loadings such as Structural Loadings, Thermal Cycling, Fatigue, Shock and Vibrations. **ASPRIA** covers all of these loadings and will therefore be innovative as this has never been done before.

ASPRIA also covers Vessels, Exchangers, Tanks and Structures, which no other system do. **ASPRIA** also covers Acoustic Pulsation, Vibration and SBB Vibration, which no other system do.

ASPRIA serves the purpose of greatly increasing Plant/Structural Integrity and Safety by predicting **more accurately than ever before** Failure of Piping, Piping Components and Equipment that would have a catastrophic effect on Human life and on the environment. A small gas leak or leak of hazardous contents can cause death and damage to the environment. None of the existing system can do that.

When leakage occurs in a Corroded Unstressed pipe or vessel, for example, then the leakage is the main problem and its consequences can be quantified in a Risk Analysis. However, this is a text book situation because ALL systems have varying degrees of stress levels and ALL have loadings other than Pressure. When stress levels exist, the Risk assessment proves unpredictable and the results can be Catastrophic and Horrific. Accident scenarios can be avoided by **Advanced On-line monitoring**, which is not available at present nor is remotely represented in any Prior Art. This system will serve that preventative purpose. All existing systems focus on the reduced wall thickness of the main pipe, however world-wide published data has shown that 85-90% of all failures occur at non-straight pipe areas such as branch

connections, elbows, etc. No system exists that assesses these areas.

ASPRIA/HEP-Tech/AP-Tech/VECOR is more than a Mathematical Modelling method, as it is a system made up of blocks of '**Permanently Installed**' Hardware. Each module itself is innovative, some of them revolutionary and can be viewed as a whole or individual systems.

The **Innovation level is high** based on the fact that:-

- No other system exists that will do the same as *ASPRIA/HEP-Tech/AP-Tech/VECOR*
- No other system assesses **all Loadings**
- No other system assesses **Acoustic Pulsation or Vibration**
- No other system assesses **SBB's**
- No other system assesses **Time Dependant No-linear High Temperature Creep**
- No other system assesses **all Components**
- No other system assesses the **Highly Stressed** parts of a system
- There is no other system like *ECPA*, that can assess the effects of Corrosion Patches on highly stressed regions.
- There is no other system like *B-Tech* that can predict System Life automatically from Live Vibration Measurements.
- There is no other system that can relate **Live Cyclic Loadings to Fatigue Life**.
- There is no other system that is '**Permanently Fixed**' to monitor the Live behaviour for Piping.
- We are pushing the frontier of Plant Monitoring beyond anything in the world today.

ASPRIA/HEP-Tech/AP-Tech/VECOR has created a system to:

1. continuously analyse, assess and verify integrity of plant in real-time;
2. transfer this data to a computer model;
3. re-analyse plant to take into account geometry changes, corrosion, fatigue, fracture, acoustic pulsations, Vibration; and
4. generate information as required, e.g. maintenance shutdown required, predicted life span of plant.

This has never before been done and will revolutionise the process plant industry.

Annex 1 - Drawings and Sketches of *ASPRIA*, *VECOR*, *HEP-Tech* & *AP-Tech*
Components